An informal interactive science and technology centre

S. Rodríguez Muñoz[a], J. Fernández Rodríguez[a], J.A. Ansín Agis[a]
A. Lago Rodríguez[b] e B. Vázquez Dorrío[c]
[a] *I.E.S. Escolas Proval, Avda. de Portugal 171, E36350 Nigrán- Pontevedra, Spain.*
[b] *Instituto de Estudos Miñoranos, Apdo. 30, E36380 Gondomar-Pontevedra, Spain.*
[c]*ETSE de Minas, Universidade de Vigo, Campus Universitario, E36200 Vigo, Spain.*

salvadorrm@eresmas.com; bvazquez@uvigo.es

Abstract. *Interactive centres are an important source of motivation and learning for Science. As a further teaching tool, a small centre for informal learning was set-up in a school, through a process in which both teachers and pupils co-ordinately and cooperatively, carried out the corresponding tasks. Outlined in this essay are the more noteworthy results in relation to the methodology used, a description of the creation process, the design and implementation of the activity and the degree of fulfilment of the objectives which were analysed through questionnaires given out to a notable sample of over 500 people who visited our interactive centre.*

Keywords. Hands-on Science, Informal Learning, Interactive Centre.

1. Introduction.

The learning of Science, as a continual process, needs to reinforce the contents that have been acquired from a formal education with additional tasks, as in many cases it is reduced to a mere collection of facts, directed discussions and occasional activities [1]. On the other hand, it is a well known fact that scientific-technological learning also occurs outside the teaching environment through everyday experiences, and that those experiences influence, in an important way, our knowledge and attitude towards Science [2,3]. In this last case, there is evidence that hands-on activities lead to a greater understanding than that of mere observation [4] and therefore it seems necessary the use of alternative models using constructivist perspectives based on the acquisition of conceptual knowledge through experience and fostering a positive attitude towards Science through the exploration of different learning environments [5]. It is extremely important, within this constructivist context, the previous knowledge, alternative ideas and the nature of the individual as it is a complementary process of the contents.

Within the existing debate concerning what these improved strategies to make Science more accessible should be, interactive centres play an important part within an informal learning context, as they also offer the opportunity to facilitate the general public's updating and to establish a link between Science and Education [6]. Interactive centres provide an opportunity of connecting theoretical and practical concepts and demonstrate Science in relation to daily application through a small semi-guided and personal investigation [7,8]. As dynamic learning environments [9] they provide a rich and structured framework were it is possible to acquire scientific-technological knowledge without the typical restrictions of formal teaching, in which in a non-sequential activity, the participant's choices are multiple and varied in accordance with their own interests and character and the teacher loses his or her regulating or evaluating role. One of the centre's aims is to increase comprehension and to bring Science closer, even though normally the focus is on its products in detriment to the nature of a scientific approach.

Our proposal was to take [10,11] with all its limitations and inconveniences, this informal learning environment to a traditional learning centre, in a process where both teachers and pupils carried out the corresponding tasks, in a coordinated and cooperative manner, with the fundamental idea that it is possible to provide an appropriate vision of the nature of Science to all kinds of public, regardless of their age or origin. The set-up of a small interactive centre called "Ciencias nas Mans" (Science in your hands)

was carried out during the last week of April 2005 in the Escolas Proval Secondary School of Nigrán which was organized by the school's seminars of Physics - Chemistry, Biology – Geology and Technology, with the collaboration of the ETSE de Minas from the Universidade of Vigo, the Instituto de Estudos Miñoranos and the 4th year pupils (who acted as monitors). This was all done as part of the "Hands-on Science" project [13] of the European Socrates/Comenius programme (110157-CP-1-2003-1-PT-COMENIUS.C3). Presented in this essay are the more outstanding results related to the methodology used, a description of the creation process, the design and implementation of the activity and the degree of accomplishment of the objectives through an analysis of a notable sample of the questionnaires filled in by over 500 people who visited the interactive centre.

2. Informal learning at school.

The interactive centre, which was assembled in the school, could be considered as a third generation museum, within the typological classifications of a museum [14], in which a dispersed set of non-contextualised concepts are presented in collections of various subject groups. This is done with the main aim of showing an interdisciplinary and pleasant view of Science, to kindle a thirst for learning, and to connect informal learning with classroom content, thus providing also a valuable experimental supplement, as well as providing the pupils with the possibility of constructing relations and understanding their daily lives through a mixture of exploration, handling and experimentation.

The exhibition [15] consisted of 50 easily reproducible interactive modules, made with easily found and low cost materials; many of them recycled (empty drink cans, yogurt pots, etc.), others that are normally found in school laboratories, and others made by pupils and teachers. The use of familiar and simple objects (Figure 1) allowed visitors to understand in a relatively small amount of time the nature of the corresponding activity, thus avoiding distracting stimulus and arousing the curiosity of the participants. The modules, which were stimulating and fun, were robust and easily handled by any age group or education and they attempt to represent small investigations rather than mere conceptual verifications. Within the experiment was the explicit construction of new meanings and interpretations of how Science works and how it affects our daily lives.

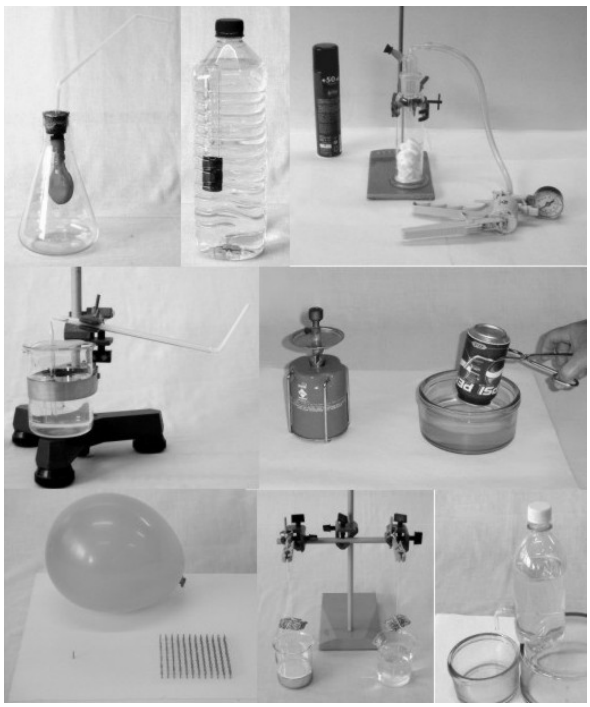

Figure 1. A selection of fluid experiments which showed the materials used.

Each module was accompanied with a self-explanatory panel (Figure 2) which, under a striking heading, contained short written and visual information on how to use them, instructions on possible applications of the contents and some thought provoking issues which attempted to cause the participants to reconsider their mental models, looking for connections with the contents of formal learning which are not evident as a preliminary and necessary step for collecting new information. Complex explanations, difficult instructions or extremely sophisticated set-ups which could inhibit the participant from exploring without help were avoided. The information provided was playful and attractive in order to attract the visitor's attention more and related in some way with the participants' previous experience. This required a certain intellectual implication which avoided the trivialisation of what was trying to be shown. More than learning, the pupils were stimulated to investigate more and to develop a situation in which they could explore for themselves and in their own way, arousing, if possible, the carrying out of further similar activities on their own.

Figure 2. An example of a self-explanatory panel.

The exhibition was initially imagined as catering to about 50 pupils at the same time (one for every experiment). In the following days we found that the space allowed for nearly 70 pupils with no difficulty or overcrowding (Figure 3). The visiting pupils were able to go to any of the experiments with no set order, moving from one to another randomly, this being the most recommendable as they could chose the experiments that most interested them, as would occur in an conventional interactive centre.

Figure 3. The running of the interactive centre.

Although the visit to the exhibition could be done as self guided (Figure 4), many of the experiments (although not all) were permanently attended by nearly 50 of the monitor pupils from the 4th year (with an average age of 16) of the actual secondary school who worked as guides or mediators and provided methodological guidelines in order to communicate with the visitors, as well as providing alternatives to the spontaneous activities of the visitors or carried out necessary adjustments when the occasion arose. In the months leading up to the exhibition, these monitors were trained in all the experiments, so that they knew how to handle and offer scientific explanations about them. It is important to point out that although around 50% of these pupils were not studying either Physics – Chemistry or Biology – Geology; their work was excellent, judging by many of the adult visitors. Throughout the time that the exhibition lasted, the monitors often changed from one experiment to another. To avoid tiring excessively and missing classes of other subjects, the group monitors worked in the exhibition on alternate days.

Figure 4. Exploring.

The visitors showed a great variety of motivations, preferences and interests in regards to learning, being in general the majority a captive public who were pupils from other schools and were visiting as part of an out-of-school activity. The exhibition was open and running during four mornings and one afternoon for the general public which was open for parents and the community, with an approximate participation on the open day of 50 people. Each morning we held two sessions which lasted two hours each with a small break in the middle. All the pupils from the Escolas Proval Secondary School attended; a total of approximately 350.

We also invited the primary schools from the Nigrán local authority and the secondary schools from the Val Miñor area (the local authorities from Nigrán, Gondomar and Baiona); giving a total of approximately 230 pupils. Beforehand, the teachers were provided with a 64 page guide book in colour, reproducing the self-explanatory panels of each of the hands-on experiments with the aim of preparing the visit to the interactive centre.

There are many hands-on experiments that exist within the bibliography which can be used in an activity as the one presented above. After an extensive revision, it was decided to make a selection by maintaining the criteria mentioned above, grouping them into seven large subject blocks which were representative of the interdisciplinary aspect of Science and with a strong link to the formal contents which were normally given to students.

The modules were designed with the aim of providing significant learning of a particular scientific-technological topic through its visualization or materialization, even though many times related multiple concepts were demonstrated. On the other hand, the free choice nature of the module caused the visitors to some times do unexpected things. The didactic use of these hands-on experiments became an aspect through which it is possible to evaluate the social dimension of learning by trying to: communicate the significance of Science and increase its understanding, to increase enjoyment in the learning process and achieve a higher active participation and implication. By involving a person actively in these activities through their senses, their memories and their enthusiasm for discovery is stimulated. Thus, they also contribute to more knowledge of Science and this is a good complement for other activities as they do not impose a teaching aspect, but more of a playful or participating aspect. These hands-on experiments not only heighten curiosity, but they also provide an opportunity for self-involvement, by relating the contents with personal meaning.

3. Evaluation of the activity.

It is difficult to evaluate the actual impact of this type of activity with such a heterogenic and diverse public in which so many variables exist [16]. In order to evaluate, it is necessary at least to collect data previously, during or after the activity. On the other hand, a strategy which tries to evaluate the scientific contents acquired during the visit is erroneous, as it seems established that knowledge is not absorbed from just one source. Thus, a survey was designed with thirteen questions, nearly all were of multiple choice, which allowed us to gather information which enabled us to evaluate quantifiable parameters such as age, sex, interest aroused by activity, degree of comprehension of the experiments proposed, the relation to daily life, availability for participation and level of previous experiences of these types of activities, as a captive public or on own initiative. Among the qualitative parameters were included questions of preference and of exclusion for a certain activity, as well as the reason for this last choice, from among four possible reasons: too obvious, did not understand, boring or did not work. Each of these exclusion reasons supposed a determined set of deficiencies about the theoretical proposal of the activity and it became a useful tool in regards to the reinforcement of knowledge, novelty, curiosity and enjoyment. The survey was handed out among students aged between 11 and over 20, from various schools who visited the exhibition as part of their out-of-school activities (Figure 5a). For a very high percentage it was their first experience of this kind, either as part of out-of-school activities from their schools (Figure 5b) or as free time activities chosen by themselves (Figure 5c), which justifies by itself the carrying out of such activities.

The degree of interest in the contents was analysed by a question which accepted as possible answers: a lot, some, and none. The overall evaluation (Figure 6a) shows an extremely high percentage of interest, evidenced firstly by the fact that there was not one negative answer registered and also being 72.00% who acknowledged a lot of interest in the contents of the interactive centre. Consequently, the theoretical subject proposed was of great interest for the public for which it was intended. In regards to the reason for this interest, and taking into account that it was a public who were undergoing learning, it seems that the proximity of the contents is a relevant factor. Other reasons may be the degree of comprehension reached during the visit. This question was also raised directly in the survey with the possible answers of; yes, no, hardly, a great part or the minimum

part (Figure 6a). None of the answers manifested not understanding the contents, 7.00% of the answers reflected a low level of comprehension against 93.00% that manifested a high or very high level of comprehension. There are many factors which influence the degree of comprehension during an informal didactic experiment; the relation to the formal contents of the selected activities, the actual set-up of the experiments or the method of transmission, from the agent chosen to be the vehicle of the message to the way it is transmitted. On this aspect, we have already commented on the important role played by the pupil monitors from the centre, who were previously shown how to carry out this important role.

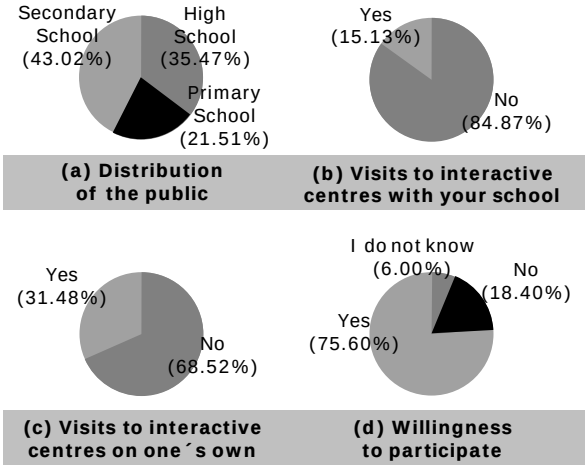

Figure 5. Main topics related with the audience.

The aspects relative to the links that the interactive centre established with the daily experiences of the participants is directly related to the interest and comprehension of the activity, so that the success of these two last parameters depend greatly on the appropriate connection of the subject shown with the daily lives and actual experiences of the public for whom it was directed. Figure 6d shows that 64.00% affirm that the activities reminded them of phenomena that occurred in their daily lives, while 36.00% do not know or cannot find clearly this relation. Undoubtedly, the majority of the visitors who answered in the affirmative correspond to a high and satisfactory level, while just over a third could not establish daily relations.

The general opinion concerning the hands-on experiments that were presented in the interactive centre was shown through the appropriate choice from a set of adjectives (Figure 6c). It is important to point out that the majority thought the experiments interesting (30.00%), funny (15.00%) or surprising (12.00%), Together with 22.00% who acknowledged that they had improved their knowledge. This last answer reinforces the previous question in relation to the individual's experience. In this section it is significant the low evaluation that is generally made of the innovative aspect of the activities against the other options.

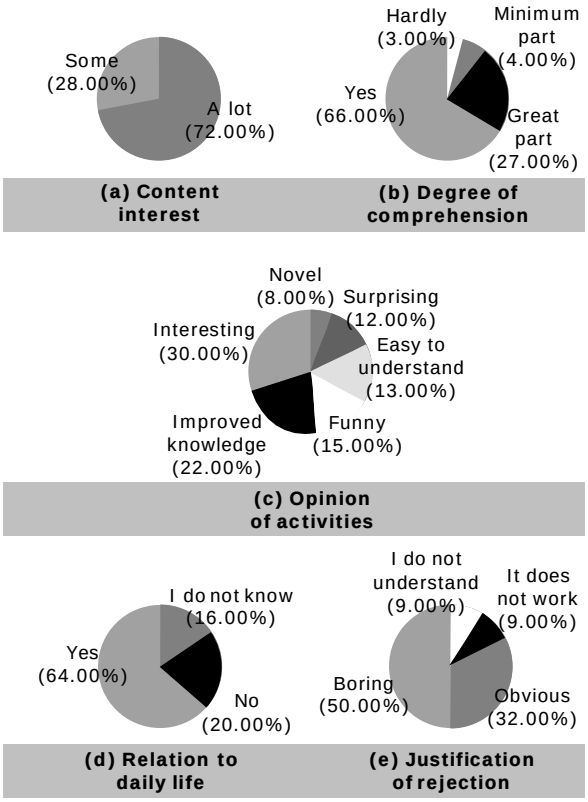

Figure 6. Main topics related with the interactive centre.

The proposal of organising similar activities in their actual learning centres (Figure 5d) appears as a very attractive proposal with a very high percentage of those who answered the survey, showing interest (75.60%) against 6.00% who would not be interested and 18.40% who were undecided.

The qualitative parameters inserted in the questionnaire were used in order to make a general evaluation of the set of hands-on activities shown in the exhibition. For this, they were asked to choose the activity they liked the most and the activity they liked the least, and in this last case, pointing out the reason for exclusion. From a total of 50 activities, there

were a group of activities that were liked more and which represent 45.00% and 7.50% who stated that they liked all of the activities. On the other hand, the set of activities which were shown as being liked less is wider and more varied, even though the preferences were also, on this occasion, centred on a group of activities which showed more parallel percentages. In this last case (Figure 5e), the main reason for their dislike was their boringness (50.00%) or for being obvious (29.00%) and to a lesser extent, the activity not working correctly (9.00%) or lack of understanding (9.00%).

4. Conclusions.

The activity carried out tried to show that Science can be something interesting, exciting and easy to understand, thus placing the importance of Science in daily life and as something that can be beneficial, by placing the student into an active and critical learning position: by experimenting, forming hypotheses, interpreting and coming to conclusions. It also tried to transmit, at the same time, the idea that scientific knowledge is basic for everyone in this present-day technical world. Although the duration of the visit was short, the visitors had a positive experience, thus becoming another important step forward in changing their relationship to Science. The public also thought that the exhibition was a useful source of information, which demonstrated daily applications of Science and that it was possible to learn something new from it. The enthusiasm shown by the participants during the activity constitutes also of its own accord an important achievement.

5. Acknowledgements.

We would like to thank the student monitors who helped and the colleagues from Escolas Proval Secondary School. We would also like to thank the local authorities Nigrán, Gondomar and Baiona for their financing, as well as the network "Hands-on Science" (110157-CP-1-2003-1-PT-COMENIUS) from the Socrates/Comenius programme of the UE.

6. References.

[1] Kelly J. Rethinking the elementary science methods course: a case for content, pedagogy and informal science education. International Journal of Science Education 2000. 22: 755-77.

[2] Rennie LJ. The communication of science and technology: past, present and future agendas. International Journal of Science Education 2003. 25: 759-73.

[3] Dierking LD, Falk JH, Rennie LJ, Anderson D, Ellenbogen E. Policy statement of the "Informal Science Education" Ad Hoc Committee. Journal of research in Science Teacher 2003. 40:108-11.

[4] Maxwell LE, Evans GW. Museums as learning settings: The importance of the physical environment. Journal of Museum Education 2002. 27: 3-7.

[5] National Research Council. National Science Education Standards. Washington DC: National Academic Press. 1996.

[6] Rennie LJ, Williams GF. Science centres and scientific literacy: promoting a relationship with science. Science Education 2002. 86: 706-26.

[7] Quin M. What is hands-on science, and where can I find it? Physics Education 1990. 25: 243-6.

[8] Wellington J. Formal and informal learning in science: the role of the interactive science centres. Physics Education 1990. 25:247-52.

[9] Barab SA, Karns D. Rethinking methodology in the learning sciences. Journal of the Learning Sciences 2001. 10: 5-15.

[10] Boone WJ, Roth MK. Organizing school science shows. The Physics Teacher 1992. 30: 348-50.

[11] Jones B. The little shop of Physics. A just-in-time science museum. The Physics Teacher 1996. 34: 514-8.

[12] http://webs.uvigo.es/eventos/h-sci/provalg.htm [05/23/2005]

[13] http://www.hsci.info/ [05/23/2005]

[14] McManus PM. Topics in museums and Science education. Studies in Science Education 1992. 20: 157-82.

[15] Allen S. Designs for learning: studying science museum exhibits that do more than entertain. Science Education 2004. 88: 16-33.

[16] Falk J. The director's cut: toward an improved understanding of learning from museums. Science Education 2004. 88: 83-96.